Wm Armstrong
Grays Inn Square
1838

A NEW SYSTEM

OF

INLAND CONVEYANCE.

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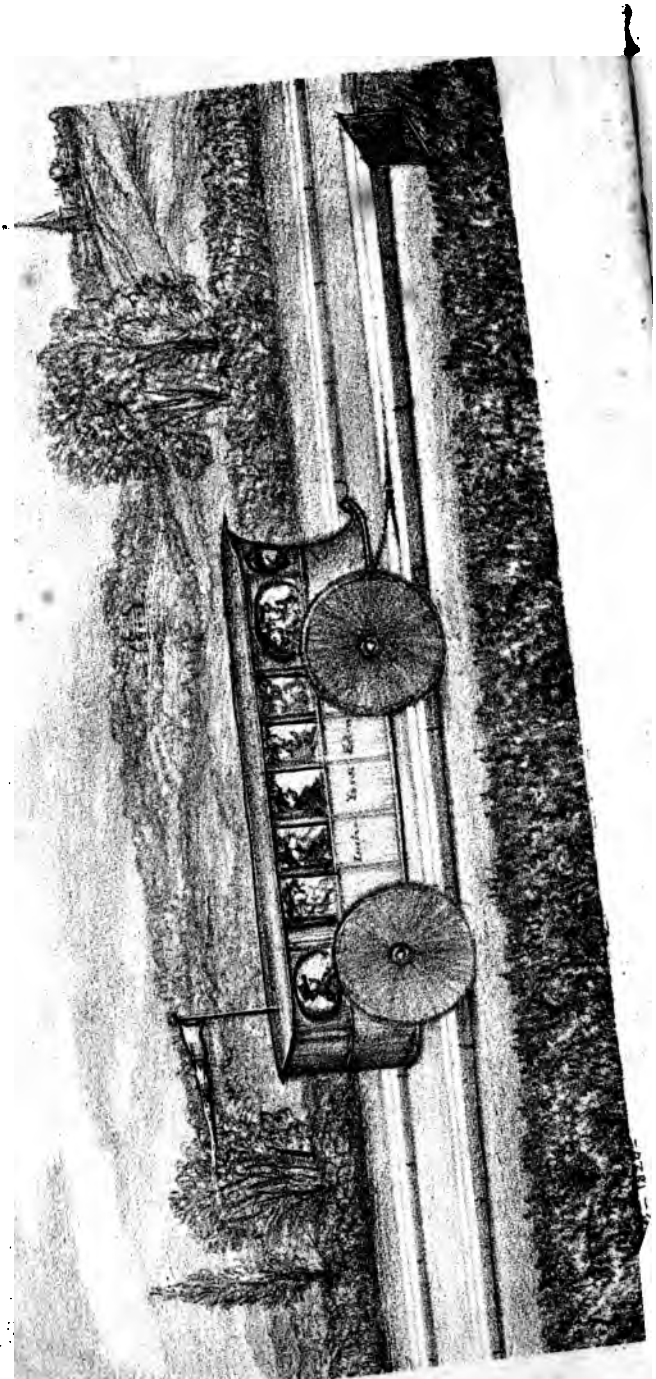

A

NEW SYSTEM

OF

INLAND CONVEYANCE,

FOR

GOODS AND PASSENGERS,

CAPABLE OF BEING

APPLIED AND EXTENDED THROUGHOUT THE COUNTRY;

AND OF CONVEYING ALL KINDS OF

Goods, Cattle, and Passengers,

WITH

THE VELOCITY OF SIXTY MILES IN AN HOUR,

AT AN EXPENSE THAT WILL NOT EXCEED

THE ONE-FOURTH PART OF THE PRESENT MODE OF TRAVELLING,

WITHOUT THE AID OF

HORSES OR ANY ANIMAL POWER.

By GEORGE MEDHURST,

CIVIL ENGINEER,

DENMARK STREET, SOHO,

London.

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A

NEW SYSTEM

OF

INLAND CONVEYANCE.

THERE is no art that has ever engaged the assiduity and energy of mankind, that is of such general utility, of such immediate and unbounded importance, of such innate and intrinsic value to the civilized world, as that of the conveyance of goods and persons from place to place, over the surface of the globe.

It is not only of itself of the highest value, but it creates and constitutes, in a very great degree, the value of all other things; for a great part of the natural produce of the whole earth is valueless to mankind for want of the means of conveyance, and the greatest part of the artificial produce is valuable only in proportion to the facility with which it can be conveyed to a market.

The immense capital, and innumerable hands,

that are employed, in this country, upon this object, and in those arts and manufactures connected with it, is an abundant proof of its importance, and of the estimation in which it stands in the vigorous minds of the British people.

A great proportion of the learning and science which embellish and dignify the mind of man, owe their birth and origin, their value and consequence, to this source. Many of the most sublime discoveries in philosophy and astronomy, many of the finest inventions in mechanics and the arts, and many of the most profound secrets of nature, have been investigated and developed, to advance, improve, and enlarge this magnificent and comprehensive science.

It therefore stands the first in dignity in the highest class; and has attracted the sagacity and policy of all nations, of all ages, and of the brightest talents in every age. It is the fountain, the current, the sinews, and the bulwark, of that superlative power, wealth, and supremacy, that has ever been, and still is, the reward of those people that embrace, and with honour maintain this envious distinction and glorious emulation.

The extensive step that is here advanced towards the perfection of an art so useful, so necessary, so honourable, and so munificent, will form a new epoch in the history of mankind, will stamp a new value upon all the productions of art and nature, and add immensely to the riches, the splendour,

the freedom, the happiness, the science, and the civilization of the whole world.

This new system is founded upon the well-known and wonderful properties of common air—the most powerful and universal mechanical agent within the reach of mankind; created and perpetually maintained by the hand of nature throughout all the regions upon the earth; not withheld from any creature, or from any spot; but is at hand in every climate, from pole to pole, ever ready to exert its utmost force, or to dispense with its own essence, for the service of mankind.

The force of air confined in a tube is well known, and the destruction it produces is often one of the most deplorable circumstances that degrades the image of the Supreme. To extend the civil employment of this powerful guardian and dreadful avenger, of this excellent servant and obedient slave, is a consummation devoutly to be wished; and this essential service it will effectually perform, without exciting any of its fury or resorting to any thing dangerous in the composition, the pressure, or confinement of it; but, by its uniform and steady impulse, it will always be prepared, with perfect subordination, to confer this extensive benefit upon mankind.

In order to apply this principle to the purpose of conveying goods and passengers from place to place, a hollow tube or archway must be constructed the whole distance, of iron, brick, timber,

or any material that will confine the air, and of such dimensions as to admit a four-wheeled carriage to run through it, capable of carrying passengers, and of strength and capacity for large and heavy goods. The tube or aërial canal must be made air tight, and of the same form and dimensions throughout, having a pair of cast iron or stone wheel-tracks securely laid all along the bottom, for the wheels of the carriage to run upon; and the carriage must be nearly of the size and form of the canal, so as to prevent any considerable quantity of air from passing by it.

If the air is forced into the mouth of the canal, behind the carriage, by an engine of sufficient power, it will be driven forward by the pressure of the air against it; and, if the air is continually driven in, the pressure against the carriage, and consequently its motion, will be continually maintained.

The interior dimensions of the canal, to answer the purpose of internal conveyance effectually, should be 6 feet high and 5 wide=30 feet in area. This will admit a carriage sufficiently large for passengers, and, in general, for all portable goods.

There will be no necessity for the carriage to fit very precisely to the canal, so as to be worn away by the friction against it, or to increase the resistance of the carriage; for if there is one inch of open space all round, between the carriage and

the sides of the canal, the quantity of air that will escape through that opening will not exceed the twenty-fifth part of the whole that is forced in, and which may effectually be compensated by increasing the power of the engine in the same proportion.

It has been found by many experiments, and by an apparatus upon a large scale, made for the purpose, that the force required to drive the air through an aperture of 1 inch square, at the rate of 30 feet in a second (or 20 miles per hour), is 6 drachms per square inch, moving at the same rate. And the force required to drive the air through a tube of 1 inch square, and 56 feet long, at the rate of 30 feet per second, is 20 drachms per inch, moving at the same rate.

Therefore the resistance, by the friction of the air against the sides of the tube, is 14 drachms, moving 30 feet per second, or as fast as the air is moved; and as there are 2,688 superficial inches in the sides of the tube, it amounts to 192 inches per drachm, which is the resistance the air meets with by the friction against the sides of the tube of 1 inch square, in passing through it at the velocity of 30 feet per second.

In tubes of the same form, and of different dimensions, the resistance will be in the proportion that the surface bears to the area.

In a canal of 30 feet area, and 6 feet by 5 in dimension, the proportion of the area to the surface

is 65 times greater than it is in a tube of 1 inch in area; and, therefore, the resistance of a surface of 12,480 inches, in a canal of these dimensions, will amount to only 1 drachm, moving at the rate of 30 feet per second, or to 47 inches in length, in a canal that is 264 inches in circumference.

In a canal that is 30 feet in area, and twenty miles long, there are 334,540,800 square inches of surface, which will give a resistance, by friction, equal to 26,806 drachms (or 104lbs.), and which must move 30 feet per second to be of sufficient power to balance this resistance.

In different degrees of velocity, the resistance, by friction, will be, as the square of the velocity; that is, the weight raised must be as the velocity, and the height must be in the same proportion.

Therefore, if the velocity be 60 miles per hour, which is 88 feet per second (instead of 30), the force to maintain that velocity, against the resistance by friction, will be equal to 305lbs. moving 88 feet per second.

The quantity of air contained in a canal of 30 feet in area, and 20 miles long, is 3,168,000 cubic feet, the weight of which is 237,980lbs., or 105 tons 18 cwt., and the pressure of it against the sides of the canal will be 2,240,228 tons. All the air within the canal must be in motion during the performance at the same rate, viz. 88 feet per second.

The time required by a falling body to acquire the

velocity of 88 feet per second, is 2.75 seconds; and the space it will fall through, in that time, will be 120 feet.

Therefore, the force required to put this body of air in motion, and give it the velocity of 88 feet per second, must be sufficient to raise a weight of 237,980lbs. 120 feet high; and if this is to be done in 20 minutes (the time that the air is to move 20 miles), it will be equal to 545lbs. moved or lifted up 88 feet per second; and this is the *vis inertia* of the body of air, or the force that is requisite to give it the motion of 88 feet per second, acting upon it 20 minutes.

Therefore, as the resistance the air will meet with, by friction, is 305lbs., and the resistance, by the *vis inertia*, is 545lbs., it will require a force of 850lbs., moving 88 feet per second, to keep the air alone in motion, at the rate of 60 miles per hour, in a canal of 30 feet in area, and 20 miles long.

The power required to impel a weight upon a well-made carriage, running upon an even iron road, will be the 60th part of the weight; and therefore a weight of 5 tons, with 10 cwt. for the weight of the carriage, will be impelled by a force of 205lbs., moving at the same rate, viz. 88 feet per second.

From hence it will appear, that the power necessary to convey 5 tons of goods through a canal of 30 feet in area, at the rate of one mile in

a minute, must be equal to the raising of a weight of 1,055lbs. 88 feet high per second,=equal to the force of 92,840lbs. moving one foot per second,= equal to the labour of 185 horses, and will be produced by the consumption of 6 cwt. of coals per hour; and, in this time, 5 tons of goods will be conveyed 60 miles, which is not one halfpenny per ton per mile.

The greatest impulse upon the carriage loaded with 5 tons, will be 6lbs. 10oz. per square foot=12 drachms per square inch; and the greatest density of the impelling air, within the canal, will be at the commencement, and this density, compared with the atmospheric air, will be as 2,188 is to 2,160, which is no more than the 77th part greater than its natural density, and less than is expressed by 4 divisions of the barometer—a difference too small to be perceived by any person within the canal.

One single canal will answer all the purposes of conveyance both ways, without any impediment, and with very little delay; for one part of the day may be assigned to the conveyance one way, and another part to the conveyance the contrary way: but the system would certainly be more complete by having two,—one to convey one way, and one the contrary.

But it is quite impossible that any accident should happen in a single one, by any mistake in any attempt to go the wrong way, for the

air that drives the carriage one way, will prevent any thing from coming the other. And carriages that are going the same way, in the same canal, can never overtake or run foul of each other; for the air that is between them will prevent their approach; and if one, by accident, should be unable to proceed, then the air could not proceed, and those following would be stopped also.

Any irregularity would be instantly shown by the impelling engine, which would be retarded or stopped by any impediment in the way, although it may be many miles distant; and in any part of the line, a barometer, communicating with the internal air, would instantly indicate any change that takes place in the density of it.

The impulse necessary to drive 5 tons of goods, upon a level road of iron, is 205lbs., the 60th part of the weight; and, if the carriage was placed upon a declivity of 1 foot in 60, it would descend by its own weight; consequently, if it is to ascend 1 foot in 60, the impelling power must be doubled (or made equal to 410lbs.), and the whole impulse or labour of the engine would be increased to 1,260lbs. (or about one-fifth more).

But, in going up hill, it is only the goods that will require a greater impulse, and not the air, for that is borne upon its own wings, and floats in its own element, and will as easily move upwards as downwards.

The quantity of air that is necessary to be driven

into the canal of 30 feet in area, to drive the air 60 miles per hour, will be 2,640 cubic feet per second; and the density of the internal air to the external has been shown to be as 2,188 is to 2,160. But, if the carriage ascends an elevation of 1 foot in 60, the internal density will be increased to be, as 2,195 is to 2,160, to enable it to ascend; and the proportion of the density for its moving on a level, and ascending an elevation of 1 foot in 60, will be, as 2,188 is to 2,195, the augmentation being the 312th part.

The additional quantity of air that must be thrown into the canal to produce this increased density, will be according to the distance it is from the beginning, or from the engine itself. If the distance is 10 miles, the additional quantity of air would be thrown into the canal in the 312th part of 10 minutes, which is less than two seconds; and so in proportion for any greater distance. By this I infer, that no sensible check will be perceived in ascending a moderate elevation, from any deficiency of the power; for that deficiency will be made up in a few seconds at the distance of 10, 15, or 20 miles from the engine.

And, if the elevation is 1 foot in 20 (equal to 264 feet in a mile), it will be sufficient to enable a carriage to pass from one end of the kingdom to the other; and the engine would charge the canal with air to that density at the distance of 20 miles, in 10 or 12 seconds.

All turnings in the canal should be avoided as much as possible; and, if unavoidable, should be made in the largest circle that can be admitted.

If the fore axle of the carriage makes an angle of 15 minutes with the hind axle, and the axles are 10 feet apart, it will cause the carriage to turn a quarter of a circle in going 1760 feet, which will be abundantly sufficient for any deviation from a straight line that need to be made in the canal; and this requires the fore axle to be moved only one-fiftieth part of an inch to make an angle of 15 minutes of a degree.

The canal might be built of brick or of timber, and may be lighted withinside by a very narrow slip of glass, to run all along the top of the canal, and guarded by a slip of wire-work. A canal of 30 feet in area, and of 26 feet exterior dimensions, will be 137,280 feet in a mile. If built of brick, of one brick and a half in thickness, the cost will be £.10 per square rod, or £.5,420 per mile.

A cast-iron road, consisting of two parallel lines of iron, of the weight of 10lbs. per foot in length, will weigh 48 tons per mile, which, at £.16 per ton, will be £.768; laying down, £.232; and the glazing iron frame and wire-work £.1,000, making a total of £.7,420 per mile. A steam engine, of 185-horse power, with the machinery necessary to force the air into or out of the canal, will cost £.20,000; and one being placed at each 20 miles distance upon the road, will amount to £.1,000 per mile, making

the expense £.8,420 per mile. Levelling the road, preparing the ground at the end and beginning of each stage, the value of the land, and contingencies, estimated at £.1,600, will increase the sum to £.10,000 per mile.

The loading and discharging of the loading, at the beginning and end of each stage of 20 miles, will be attended with some difficulty, and must be managed with care, method, and contrivance.

The beginning of the canal must be closed with air-tight gates, that the air may be driven through the canal; and the air must enter the canal through an aperture in the side of it, behind the carriage; but the end that is farthest from the engine may be always open.

When the carriage arrives at the end of each stage of 20 miles, where it must stop to deliver and receive goods, it is evident that, going at the rate of 88 feet per second, it cannot be stopped suddenly, for that would dash it to pieces, and every thing in it; but if it is made to ascend an elevation of a proper height, it would stop of itself, without injury, or any violence or danger.

It has been shown, that a body falling by its own weight will acquire a velocity of 88 feet per second, in falling 120 feet; and, therefore, a body moving horizontally, with this velocity, will ascend to the height of 120 feet perpendicular before it would stop, if there is nothing to stop it but its own weight. But, the moment the carriage gets

out of the canal, it meets with the outward air, which immediately presents a resistance, while under that velocity, equal to 5 cwt.; and this resistance, gradually diminishing, would stop it in passing upon a level for the space of 550 feet.

Hence, the carriage may be made to rise just as much as is required or convenient, according to the situation of the place, by placing the elevation nearer or farther from the end of the canal. If it rises 10 feet perpendicularly, it will be sufficiently elevated to pass down, by its own weight, into the mouth of the succeeding canal, to continue its journey.

A steam engine, for this purpose, must have a cylinder 30 inches in diameter; and must make 30 ten-feet strokes per minute, working a fly wheel with a treble crank, each crank working a pump containing 1,760 cubic feet of air, which pump must be 14 feet in diameter and 12 feet deep, and the three pumps will throw a continual stream of air into the canal amounting to 2,640 feet per second.

These pumps should be made of wood, open at bottom, and bound with hoops, like a vat; and should be plunged up and down in a bason of water, by which means they would not require a piston, would work without friction and without grease, would lose none of their contents, and would remain perfect as long as the material would endure.

In some situations a fall of water may be

obtained sufficiently powerful to produce the full effect, especially if the canal is smaller than the dimensions here given, or the motion slower; for the power being as the square of the velocity, a velocity of 20 miles per hour would be given by an engine of the power of 20 horses.

And there is no situation in which the power of the wind might not be made to produce a regular, permanent, and continual mechanical power, to a very great extent, so as to answer the purpose, in an effectual manner, where fuel cannot be procured.

The machinery for the pumps, if designed to be worked by steam, may be made and arranged as follows:—

FIG. 1.—*A*, the cylinder of the steam engine, with its piston, parallel, condenser, regulator, &c. as usual. *B*, the beam, connected to the fly wheel *D*, by the shaft *C*.

In a line of the axis of the fly wheel, must be placed three single cranks, *a*, *b*, *c*, at the distance of 16 feet from each other, and making an angle with each other of 120 degrees. These are each connected by rods *d*, *e*, *f*, to their respective pump beams, *g*, *m*,—*h*, *l*,—and *i*, *k*, which move upon the centre *g*, *h*, and *i*, and are connected at their other ends by the rods *k*, *l*, *m*, to the air vessels *o*, *p*, *q*, that are to rise and fall, in a bason of water, either to force the air into the canal, or to draw it out, as occasion requires.

The air vessels are kept in a parallel position by

a slight beam at their lower extreme; they each have a double pipe fixed under them with their mouths just above the water, furnished with proper valves, and communicating with the canal. Through these pipes the air will pass into the canal, by the motion of the pumps; or be drawn from it, and discharge into the open air, as required, by turning the cock, either to impel or to exhaust it.

When the carriage is to go through the canal, from the engine, the air must be forced into the canal behind it; but, when it is to go the contrary way, the same engine is to draw the air out of the canal, and rarify the air before the carriage, that the atmospheric air may press into the canal behind the carriage, and drive it the contrary way.

When the carriage is going out from the engine, it will get into motion immediately the air is driven in behind it, and in a few seconds will acquire its ultimate velocity; but when it has arrived at the end of the canal, at 20 miles distance, the air will continue its rapid motion after the engine is stopped, and will continue to move with a decreasing velocity for 1 hour, by its own momentum.

For it has been shown, that the time required to give a velocity of 88 feet per second to a body or weight, by its own weight, is 2.75 seconds; and in the same time it would stop it, if opposed by its own weight. But, if this weight of air, amounting to 237,937lbs., has only the friction of the canal to stop it, which is 305lbs., it will continue its motion 1 hour after the engine has ceased to impel

it, and nothing could resist its progress but time; for so great a weight would burst the canal, and immediately get vent, if attempted to be stopped in too short a time.

On the other hand, when the engine begins to draw the air out of the canal, to draw the goods backward (or in towards the engine), it will be 15 or 20 minutes before the air is rarified at the farther end of the canal, at 20 miles distance, and, consequently, before the carriage can begin its motion homeward. So that there must be an interval of one hour and a half, in every stage, before the motion can be changed, except there are two canals, one to go constantly one way, and one the other.

It is practicable, upon the same principle, to form a tube so as to leave a continual communication between the inside and the outside of it, without suffering any part of the impelling air to escape; and, by this means, to impel a carriage along upon an iron road, in the open air, with equal velocity, and, in a great degree, possessing the same advantages as in passing withinside of the tube, with the additional satisfaction to passengers of being unconfined, and in view of the country.

If a round iron tube, 24 inches in diameter, be made, with an opening of 2 inches wide in the circumference, and a flanch 6 or 8 inches deep

on each side of the opening, it will leave a channel between the flanches, and an opening into the tube. If the flanches of this tube are immersed in water up to the circumference, as represented in FIG. 3, where *a, a,* is a section of the tube; *b* the channel; and *c, c,* the surface of the water.

If such a tube is laid all along upon the ground, with the iron channel immersed in a channel of water, up to *m,* and a piston or box made to fit it loosely, and pass through it upon wheels or rollers, this box, driven through the tube by the air forced into it, may give motion to a carriage without, by a communication through the channel and the water.

No air can pass out of the tube while the channel is immersed in water, unless the air is of such density as to force the water out of the channel, and then the air will follow it and escape; but there is an opening made for a bar of iron to pass from the running box, in the interior of the tube, down through the water to *n,* to which a rod or crank may be brought from the carriage in the open air, and from that receive its motion.

If the channel is immersed 6 inches deep, it will bear a pressure of 4oz. per inch, which is 103lbs. in the whole tube of 24 inches in diameter.

A round tube of iron, 24 inches in diameter, and half an inch thick, with two flanches 6 inches deep, will consist of 533 cubic inches per foot in length, 2,814,240 in 1 mile, and 28,142,400 in 10 miles; and the weight will be 314 tons per mile.

The quantity of interior surface in this tube is 904 square inches per foot in length, 4,777,344 per mile, and 47,773,440 in 10 miles. The proportion of the surface to the area is as 1 to 5.5; and, compared with a tube of one inch in area, it will be as 1 to 22. Therefore, the resistance, by friction, which the air will meet with, moving 30 feet per second, through a tube of these dimensions, and 10 miles long, will be equal to 42lbs. moving with the same velocity.

The quantity of air contained in a tube of this diameter, each foot in length, is 4,976 cubic inches; in one mile, 15,204 feet; and, in 10 miles, 152,040 cubic feet.

The weight of this air is 11,421lbs. (5 tons, 2 cwt.) This weight will give itself the velocity of 30 feet per second, in one second; and, therefore, the 1800th part of the weight, viz. 6lbs. 5oz., acting upon it 1800 seconds (or 30 minutes), and moving 30 feet per second, will produce the same effect, and will be equal to the *vis inertia* of 5 tons, 2 cwt. moving 30 feet per second.

A carriage, loaded with 12 persons, and of the weight altogether of 2,000lbs, will be impelled, upon a level iron road, by a force of 33lbs.; and, therefore, the force required to impel the air through a tube 24 inches in diameter, and 10 miles long, at the rate of 20 miles per hour, with a carriage carrying 12 persons, will be equal to 82lbs. moving 30 feet per second; and the pressure

against the inside carriage, or box, will be 3oz. 2 drachms per square inch, equal to the pressure of 5.4 inches high of water, which is equal to the mechanical power of 5 horses; and will be maintained by 112lbs. of coals for 3 hours and 30 minutes.

The weight of the tube being 314 tons per mile, at £.12 per ton, will be £.3,768 per mile. If the iron road, and the laying down, be £.1,600 per mile, the whole preparation will amount to £.5,368 per mile.

In consequence of its lying in a channel of water, it must, of course, lie level; and cannot be made to rise or fall gradually, as the canal will. But it may be made to ascend at intervals, without stopping; for, if the tube was made to raise up into another level, of not more than 10 or 12 feet higher, the carriage would ascend, and follow it up an inclining plane, by the force of its own velocity, rising over the height, and then sinking down into the channel, it would go on, in the higher level, as before.

But the greatest objection to this mode, and of the dimensions, is, that it is exposed to the wind, which would not only vary its velocity, but, the power being so feeble, it would entirely stop it, when any strength of wind was against it; while the carriage within the aërial canal cannot be affected by the winds nor the weather, by the frost nor the snow, but might continue its course, under all the vicissitudes of nature, from one end

of the kingdom to the other, so that a man might breakfast in London, dine at Edinburgh, and return to London within twelve or fourteen hours of his departure; and his travelling expenses, for this transit of 800 miles, would be paid with one sovereign.

A PLAN to combine the two modes together, that the goods may be conveyed within the canal, and a communication made from the inside to the outside of it, so that a carriage may be impelled in the open air, to carry passengers, would be an improvement desirable and practicable. It must be effected without the aid of water, that it may rise and fall as the land lies; and it must give a continual impulse to the outside carriage, without suffering the impelling air to escape.

For this purpose, there must be some machinery which will diminish the simplicity, make it more expensive, and more liable to be disordered, unless executed in the most substantial and perfect manner; but, by skill, by experience, and sound workmanship, it may be accomplished in various ways, one of which I will describe, which, I presume, will evince the practicability of it.

In order to make this in the best manner, the top of the canal should be made of wrought-iron (or copper) plates, riveted together, and riveted all along, on one side, to a cast-iron rail securely laid upon the top of one of the side walls; and

made to shut down close, and air-tight, upon a cast-iron rail laid firmly down upon the other side wall.

In order to make the plate shut down air-tight upon the cast-iron rail, without being riveted to it, there should be a groove all along, upon the top and inner edge of the cast-iron rail, and a thin edge of iron riveted to the plates all along, to fall into the groove; then, if the groove is partially filled with some soft and yielding substance, as cork, wood, leather, hemp, &c. the thin iron edge will bed itself into it, and shut so close that the air will not escape, with so light a pressure as 1 pound per square inch.

The plate that is to form the top of the canal, being thus prepared, may be lifted up out of the groove two or three inches high, in any particular place of the side that is not riveted; and, when let down again, the edge will fall into the groove, by the spring and weight of the plate, and stop close as before.

Therefore, if there is a large and light iron wheel fixed in the front of the interior carriage, and close to the side wall on which the plate shuts into the groove; and if this wheel is planted to stand two inches higher than the under side of the covering plate, this wheel, as it passes along, will constantly lift up the plates, and make an opening of two inches wide, or more, and 8 or 10 feet long; and, when the wheel has passed, the plate will fall down into the groove, and close the joint, as before.

Through this opening, a bar of iron may pass, that is fixed to the interior carriage; it may project over the side wall, and the outer end may be attached to the exterior carriage by a chain or strap, and pull it along upon its own wheels and wheel track, which should lie along by the side of the wall of the canal.

The iron bar will not touch any thing as it passes through the opening, for the iron covering may be lifted up two or three inches high; but the bar need not be more than one inch in thickness.

And, whatever the opening is, the air that escapes through it will not retard the progress of the carriage, but rather assist it; for the air that escapes is not the air that is driven into the canal to impel the carriage, because this is before the vane, and not behind it, where the impelling air must be. The air that is before the vane requires a great impulse itself to drive it forward through the canal; and, therefore, the more that escapes out of it, the less is the density and resistance of the remainder.

But if the opening in the canal should, contrary to my judgment, be found objectionable, it is not at all impracticable to communicate any force from the inside to the outside of the canal, without the smallest opening, and without the aid of any fluid, leaving the canal, on all sides, perfectly impervious to the air, even under the heaviest pressure of many atmospheres.

This, and a great variety of schemes, applicable

to various purposes and relative to various parts of this system, are omitted, that my work might not exceed the limits I had prescribed.

FIG. 4 is a section of the inside of the canal *a, a, a, a;* and the iron top *b, b,* with the cast-iron plate on the top of the wall *c, c,* and *a, d,* with the groove *a,* and the edge of the plate shutting into it, *n, n,* represents a section of the lifting wheel that is to project above the plate, and to lift it up as it rolls along under it, to admit the iron arm *m, m,* from the carriage, to pass through into the open air, to draw the outside carriage. The dotted line represents the top plate as lifted up.

When the carriage is turned, to go the other way, the lifting wheel *n, n,* and iron arm *m, m,* must be shifted to the other side of the carrriage at *a, c,* that they may be on the opening side of the top.

The iron plate, on the top of the canal, will weigh 4lbs. per square foot, and 20lbs. every foot in length; this, with the labour of riveting together, and to the side, with the two side plates of cast iron, will cost £.1 per foot in length, or £.5,280 per mile.

The two sides of the canal, of 6 feet high each, and the bottom of 7 feet, will be 19 feet of brick-work each foot in length; 100,320 feet in a mile, equal to 368 rods; which, at £.10 per rod, is £.3,680 per mile.

The two iron roads, one within and one without the canal, £.2,000 per mile; the engine, £.1,000;

the expense for levelling, embanking, &c., £.1,600; the whole will amount to £.13,560 per mile.

THE same principle, and the same form, may be advantageously applied to convey goods and passengers in the open air, upon a common road, at the same rate of a mile in a minute, or sixty miles per hour; and without any obstruction, except, at times, contrary winds, which may retard its progress, and heavy snow, which may obstruct it.

If a square iron tube be formed, 2 feet on each side, 4 feet in area, with three sides, and one-half of the top, of cast iron, the other half of the top made of plate iron or copper, to lift up and shut down in a groove in the cast-iron semi-top plate, as before described; and if a strong and light box or frame be made to run upon wheels, within the tube, and an iron arm made to pass out, through the opening made by lifting up the plate, as before described, this arm may give motion to a carriage in the open air, and upon the common road, without any rail-way, if the pressure within the tube is made strong enough for the purpose.

The opening of the iron plate should be made in the middle of the top, so that the iron arm may pass out, and stand upright a few inches above the top, to which the strap should be attached, to communicate motion to the carriage.

The frame or box, within the tube, should be 10 or 12 feet long, and must be guided by wheels, on all sides, as large as can be admitted, and as truly formed and planted as possible; the number will be fourteen or sixteen.

A piston, or vane, must be formed near the middle of the frame, to intercept the air, and must be leathered all round, so as lightly or barely to touch the sides of the tube.

The inside, or middle of this vane, should be open, and the opening filled up and closed by a valve, suspended by an axis across the middle of the opening, so that this valve, by turning on its axis, may open the vane, and suffer the air to pass through, and prevent its impulse upon the vane and carriage, or, by closing the valve, intercept the air, and give it motion.

By this means, the conductor of the carriage may restrain and limit the velocity, and stop the carriage, at any time and at any place, by a communication from the valve, through the opening, to the conductor on the outside; and this will be done without the least violence, shock, or chance of disordering any thing, either within or without.

FIG. 5 represents the vane within its frame *m, m, m, m;* the outside edge of the vane, *a, b, c, d,* is leathered all round, and the middle part, *o, p, q, r,* is open, and is to be closed by the double valve, that is to turn upon its vertical axis *e, e.* The valve will shut, half on one side of the vane *a, b, c, d,* and half on the other; when it is shut,

the air will be intercepted, and the impulse of the air will be given to the carriage; but, when the valve is turned a quarter of a circle, it presents its edge to the air, and leaves the interior of the vane open for the air to pass by unobstructed, when the carriage will gradually be stopped, by the friction of the road and the resistance of the outward air. It may be put in motion again, as soon and as gradually, by closing the valve.

m, m, m, m, is the box, or open frame, that is to pass through the tube, on the wheels *n, n, n, n, n*, to support the vane, and the iron arm, and to be impelled by the air in the tube.

FIG. 6 is a section of the iron tube, with the wrought-iron semi-top, *a, b*, riveted to the flanch, and represented as lifted up by the projection of the wheel under it; and of the crooked iron arm *n*, as it is to come out through the opening, and stand up for the carriage to be attached to it.

The semi-top of cast iron, *o, p*, is to be screwed upon the tube by the flanch *p*, and, at the edge *o*, is a small projection, which the edge of the wrought iron is to cover, to prevent the rain or dust from entering into the tube.

FIG. 7 represents a part of the tube, with the semi-top as lifted up at *m*, and the section of the crooked iron arm, *n*, as it is to pass out of the opening, besides the wheel that lifts it.

The iron tube should lie in the ground, with the top of it a few inches above the surface; and the carriage should run over it, with the wheels on

each side; then the iron arm *n*, would draw the carriage in the fairest position.

The opening being, in this plan, made in the middle of the top of the tube, instead of the side, the lifting wheel will act either way, without being removed; but the iron arm that passes through the opening (to draw the carriage), as well as the arm that is to pass through (to open and shut the valve), must be changed to the other side, when the motion is changed to a contrary direction.

If the carriage is attached to the regulating arm that is to pass through the opening, and that arm is supported by the main bar, the effect will be, that, if by any accident the chain should let go its hold of the arm, the inside valve would instantly fly open; and the vane, being no longer impelled, would soon stop of itself, and the chain might be replaced.

The road, or track, for the wheel, should be raised, to keep it dry; it should also be prepared of the best materials, paved with some hard and heavy stone, and be fenced in by paling, by embanking, or by a live fence, to prevent any cattle or any person from doing injury or causing accident.

The outside carriage should be 20 feet long, and not more than 3 feet wide, with a vertical edge before and behind, as represented in the frontispiece, that it may pass through the air with the least resistance from the opposing winds, or the pacific atmosphere.

The wheels should be as light and as strong as

possible; and, to this end, the interior should be filled up; if they are 5 feet diameter, they must turn round 6 times in a second, and the top of the wheel will move at the rate of 180 feet per second.

The wheels should be fixed to their respective axles, and each wheel should have its own axle and its own spring, that the wheels may partake of the unevenness of road, without affecting the carriage.

The interior surface of a tube, 2 feet square, will be 96 inches per inch in length, 1,152 square inches per foot, 6,082,560 inches per mile, and 121,651,200 inches in 20 miles.

The proportion of the area to the surface is 6 to 1; and the resistance, by the friction of the air against the sides of a tube 20 miles in length (the air moving 88 feet per second, 60 miles per hour), will be equal to 302lbs., moving at the same rate, or 26,576lbs., moving one foot per second.

The quantity of air contained in this tube, each foot in length, is 4 feet cubic; in one mile, 21,120 feet; in 20 miles, 422,400 feet. The weight of the air in 20 miles will be 31,730lbs. (14 tons, 3 cwt.); but, as the density will be increased, by the force of the engine, in the proportion of 16 to 15, the weight will be increased to 33,840lbs., and the momentum of this weight moving 88 feet per second, is equal to a weight of 77lbs., moving 88 feet per second, for 20 minutes; in which time the air will have passed from one end of the tube to the other.

If the weight of the carriage and load is 6,000lbs., the resistance it will receive upon a common road, by the friction of the wheels, will be a 30th part of the weight; it will, therefore, be 200lbs., moving 88 feet per second. And if the road rises 1 foot in 30, or 176 feet in a mile, the force must be double, *viz.* 400lbs.

The surface presented by the front of the carriage to the air, as it passes through it, cannot be less than 15 square feet; and the carriage going at the rate of 60 miles per hour, the still air will present a continual resistance of 260lbs.

From these calculations it will appear, that the force necessary to convey 5 tons of goods 60 miles per hour, upon a common road, will be as follows:—

	lbs.
Resistance by the friction of the tube	302
Resistance by the *vis inertia* of the air ...	77
Resistance by the wheels of the carriage	400
Resistance by the ambient air	260

which amounts to 1,039lbs. moving 88 feet per second, or 1lb. 13oz. pressure per inch upon the vane, which is equal to the power of 182 horses, and will be maintained by steam engines 20 miles apart, and by the consumption of 6 cwt. of coals per hour, which, according to the price of coals in London, does not amount to two farthings per ton per mile!!!

A cast-iron square tube, of 4 feet in the area, with one half of the top open, with the flanches on

each side, and being half an inch in thickness, will weigh 150lbs. per foot in length, and 792,000lbs. per mile, equal to 353 tons.

If two tubes are laid down upon the same road, one to convey one way and one the other, their weight will amount to 700 tons per mile, which, at £.10 per ton, will be £.7,000 per mile.

If the movable plates be estimated at £.500 per mile each tube, laying down, the tube, and making the road, at £.1,000 per mile each; two engines at each station, at 20 miles distance, at £.20,000 each, will be £.2,000 per mile; the whole expense of this mode of conveyance will be £.12,000 per mile.

If a double line of this road is laid down through the kingdom, with branches to the most eminent places of trade and commerce, it might amount to 1,000 miles, and the expense to £.12,000,000.

Although the perfection of this work is not to be obtained but by time, skill, experience, and the wealth of a nation, yet, upon a smaller scale, and less rapidity, the expense will be moderate, and within reach; and the value of it, compared with the present mode of conveyance, would be abundantly advantageous and desirable.

A small tube, of 6 inches diameter, might be prepared and laid down, at £.2,000 per mile, which would convey passengers, in a common carriage, upon a common road, at the rate of 15 miles per hour,—a rapidity that is far beyond the

view, or even the hopes, of the most sanguine, upon any principle that has hitherto engaged the attention of mankind.

In the year 1810, I published a short account of this invention, entitled, "*A New Method of conveying Letters and Goods by Air*;" and, two years afterwards, I published some calculations and remarks tending to prove the practicability of the scheme.

These publications met with that indifference and contempt, which usually attend all attempts to deviate so widely from established customs; for it is the fate of every one who dares to wander out of the beaten path, in search of fame or fortune, to encounter innumerable obstacles thrown in his way, by the habits, the prejudices, and the interests of mankind; if he is unsuccessful in his pursuits, ridicule and ruin are always ready to present themselves, to aggravate his misfortune. If truth and science should declare in his favour, they are of such feeble influence, that envy and interest eagerly combine to snatch from his trembling hand the sapless sprig of fading laurel, which the apathy of the world reluctantly bestows upon his labour.

Such are the views of an ardent mind, to give wings to the commerce of the world, from shore to shore; and no one can say how far it is possible to create new principles of power, and invent new modes of application, that may open a boundless scene, and an inexhaustible source of improvement

upon the sea. But even that grand and plausible design of steam navigation was above a hundred years in working its way, through multitudes of opponents and mountains of prejudice, into public favour; who then shall dare to obtrude again into this dangerous province? who shall presume to suggest an innovation against the terrible experience of ages; or to advise the fearless and confident veteran how he may outstrip the winds, and set at defiance the utmost fury of the enraged elements?

"This eternal blazon," perhaps even now, sits trembling upon the lips of time, fearful of being also doomed to wander many ages on the banks of despair, an object of pity, of poverty, and of contempt.

After all is done that this system can embrace, there will still remain a vast extent of the country, and many thousand miles of road, that this aërial canal cannot reach.

There is still a boundless field for the application of steam in another mode, which will very far surpass in economy, conveniency, safety, expedition, and ease, the means of travelling that stage coaches, by horses, ever can attain.

This application of steam to a carriage I have put in actual practice, and have, at this time, two carriages, with a steam engine to each, that are

capable of going upon the common road from 5 to 7 miles per hour; one of them is capable of carrying 4 persons, and both are driven entirely by steam.

The first of these was made in the year 1819, and tried with success, in the New Road, between Paddington and Islington, on the 3rd of April, 1820, and again on the 6th of July, the same year; it was, at that time, made chiefly of tin, but was afterwards renewed, and made of copper, and exhibited in the same road, on the 3rd of May, 1821, and again on the 12th of June, in the same year, when it must have been seen, by some hundreds of people, passing through the streets into the road, through the turnpike gates, and up and down Paddington Hill, at the rate of 5 miles per hour, carrying one person, and its own fire, water, and fuel. The same carriage was again exhibited, on the same ground, in a more perfect state, on the 29th of June, 1821.

Another engine and carriage was then put in hand, upon an enlarged scale, and more perfect and substantial machinery; they are both now in a finished state, and ready for sale. The last will carry 4 persons, at the rate of 7 miles per hour, with its own fuel and water for one hour, with which it feeds itself continually.

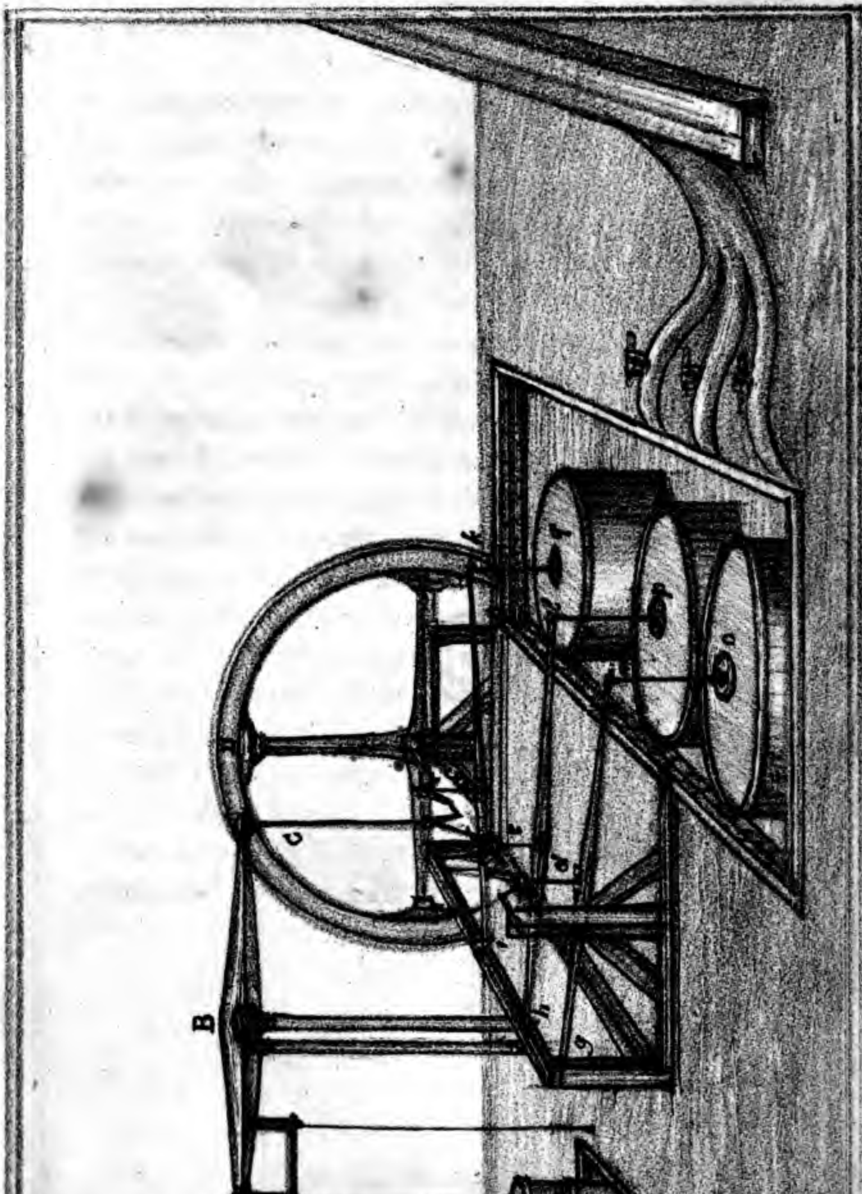
The progress of this scheme has been delayed for some years by a most severe family affliction; and, finally, a heavy and irreparable loss. It will be resumed, and shortly exhibited in a state of

progressive improvement, in full confidence of approaching maturity.

But I am not accountable to any individual, or to the public, for any delay or variation in my design on these subjects, as I am under no promise or obligation to any one; and my humble situation, and slender means, are an ample apology for all delays that have or may occur.

For although I have long paid my adoration to this aërial and invisible deity,—have devoted the leisure of many years to the contemplation of the virgin virtues of this celestial stranger, I have not solicited or accepted of any aid, mental or material, of any one living; and, therefore, this free-will offering is entirely my own,—the pure effulgence of an untaught mind, and of limited talents; and, as such, I dedicate to the world this jewel of inestimable value, explored and discovered in the mines of experimental philosophy, by the eye of reason, briefly polished by the wings of fancy and enthusiasm, to display the latent brilliancy, and refulgent water, of this mechanic gem, which is here unveiled for the admiration and enjoyment of future ages.

FINIS.



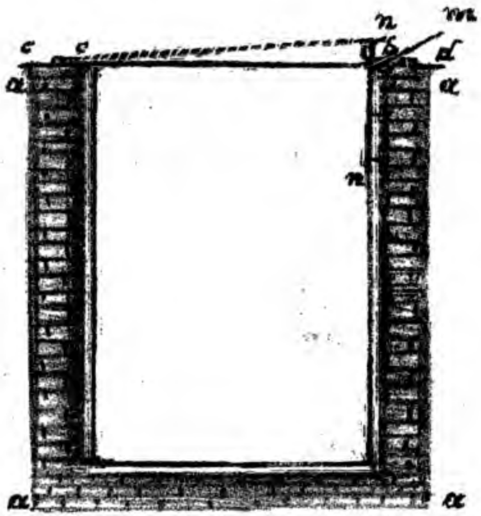


Fig. 4.

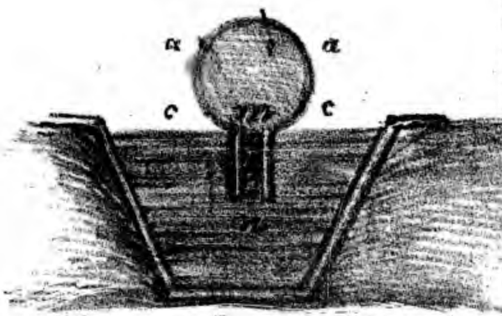
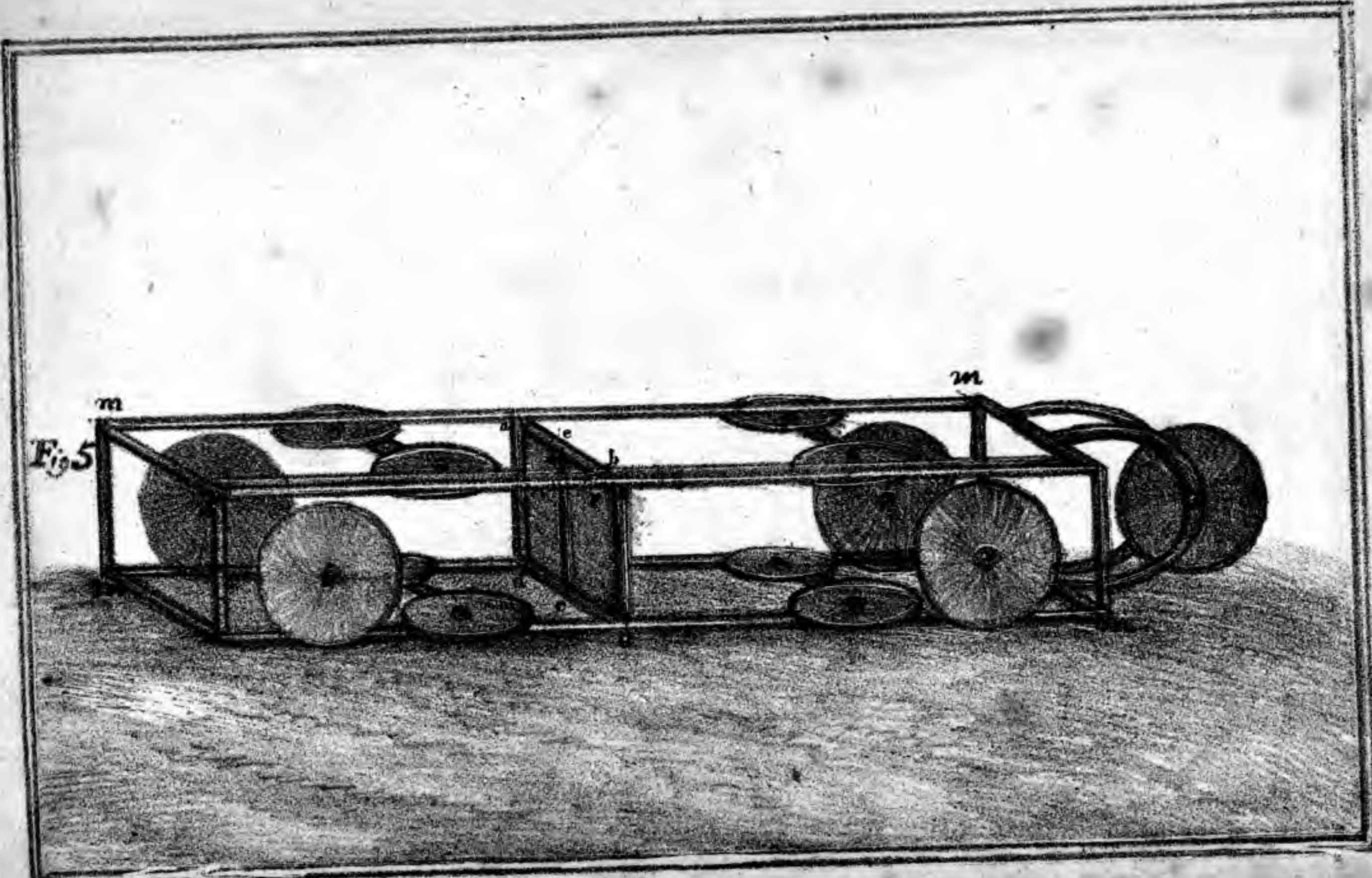


Fig. 3.

Fig. 5



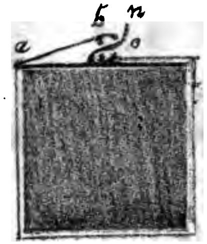


Fig. 6.

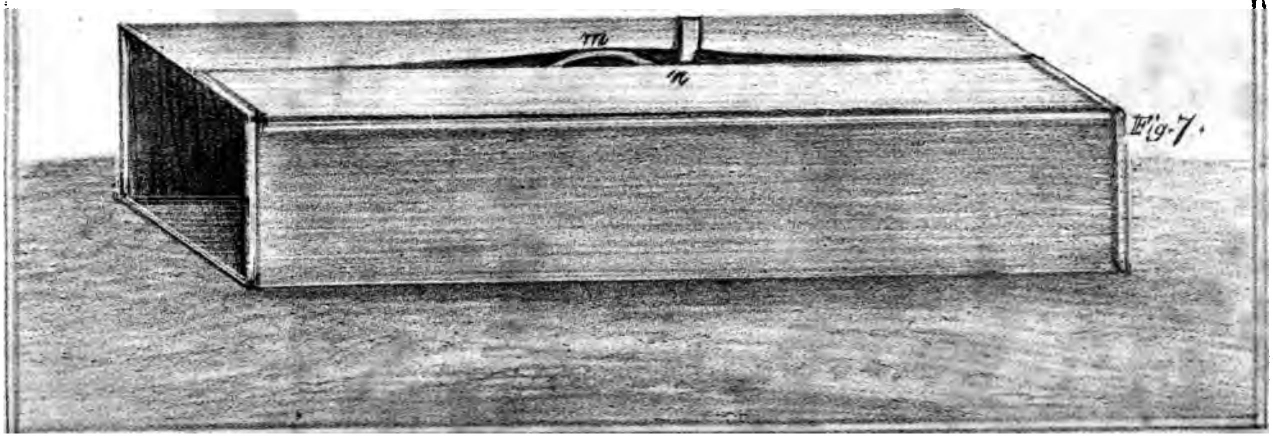


Fig. 7.